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MEMORANDUM FOR MILITARY/INDUSTRY DISTRIBUTION

SUBJECT: Initial Draft of MIL–PRF–31032A, MIL–PRF–31032/1B, MIL–PRF–31032/2A, MIL–PRF–31032/3A, and MIL–PRF–31032/4A; Project Numbers 5998–0133, –0133–01, –0133–02, –0155, and –0156

The initial drafts for these subject documents, dated March 25, 2004, are now available for viewing and downloading from the DSCC-VA Web site:

http://www.dscc.dla.mil/Programs/MilSpec/DocSearch.asp

These documents are being revised to update all documents to current MIL-STD-961 requirements. Major changes to these document include the altering appendix A from guidance to mandatory, the addition of capability verification inspection in appendix C, and modifying the specification sheet requirements to align with the changes in MIL–PRF–31032.

If these documents are of interest to you, please submit your typed comments or suggestions using electronic mail or by letter. Comments or suggested changes that are not editorial in nature should include justification. Industrial activities should indicate whether they are commenting from the standpoint of a "User" or "Manufacturer." Military review activities should forward comments to their custodians in sufficient time to allow for consolidating the departmental reply. Navy review activities are requested to send comments to this center in lieu of the Navy – EC custodian. All agencies, industry, and coordinated custodian comments should be sent to this center. Comments originating from military departments must be identified as either "Essential" or "Suggested." Essential comments, which must be accepted or withdrawn, should be supported by supporting data unless they obviously require no data.

Concurrence or comments are required at this Center within 45 days from the date of this letter. Late comments will be held for the next coordination of the document. Any further coordination concerning these revisions will be circulated only to firms and organizations that furnish comments or reply that they have an interest.

The point of contact for this document is Mr. David Corbett, Defense Supply Center Columbus, DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000. Mr. Corbett can also be reached at (614) 692-0526/850-0526, or by facsimile (614) 693-1642, or by e-mail to: 5998_Documents@dscc.dla.mil.

/Signed/

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cc:
VSS
VQE

The document and process conversion measures necessary to comply with this revision shall be completed by (6 months from document date).

METRIC

MIL-PRF-31032/3A
D R A F T
SUPERSEDING
MIL-PRF-31032/3
22 June 1997

PERFORMANCE SPECIFICATION SHEET

PRINTED WIRING BOARD, FLEXIBLE, SINGLE AND DOUBLE LAYER, WITH OR WITHOUT PLATED THROUGH HOLES, WITH OR WITHOUT STIFFENERS FOR SOLDERED PART MOUNTING

This requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-31032.

1. SCOPE

* 1.1 Scope. This specification covers the generic requirements for flexible, single and double sided (one or two conductor layers) printed wiring boards (hereafter designated printed board) with or without plated holes and with or without stiffeners that will use soldering for component/part mounting (see 6.1.1).

1.2 Classification. Printed boards covered by this specification are of the following types and usage classes.

1.2.1 Types. The printed boards covered by this specification are of the following types, as specified (see 6.2.e).

Type 1 - Single-sided flexible printed board.

Type 2 - Double-sided flexible printed board.

1.2.2 Usage. The usage classes following describe the possible usage/application of the printed boards (see 6.2.f).

Class A - The flexible printed board is capable of withstanding flexing during installation.

Class B - The flexible printed board is capable of withstanding continuous flexing for a number of cycles specified in the printed board procurement documentation (see 6.2.1.c).

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

* 2.2 Government documents. The following specification forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-31032 - Printed Circuit Board/Printed Wiring Board, General Specification for.

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

* 2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those cited in the solicitation or contract.

* ASTM INTERNATIONAL (ASTM)

* ASTM E345 - Standard Test Methods of Tension Testing of Metallic Foil.

* (Application for copies should be addressed to the ASTM International, 1916 Race Street, Philadelphia, PA 19103-1187 or http://www.astm.org.)

* ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

J-STD-003 - Solderability Tests for Printed Boards.
* IPC-2221 - Generic Standard for Printed Board Design.
* IPC-2223 - Sectional Design Standard for Flexible Printed Boards.
IPC-TM-650 - Test Methods Manual.

* (Application for copies should be addressed to the Association Connecting Electronics Industry, 2215 Sanders Road, Suite 200 South, Northbrook, IL 60062-6135 or http://www.ipc.org.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Printed board detail requirements. Printed boards delivered under this specification shall be in accordance with the requirements as specified herein, and documented in the printed board procurement documentation.

3.1.1 Conflicting requirements. The order of precedence of conflicting requirements shall be in accordance with MIL-PRF-31032.

3.1.2 Reference to printed board procurement documentation. For the purposes of this specification, when the term "specified" is used without additional reference to a specific location or document, the intended reference shall be to the applicable printed board procurement documentation.

3.2 Qualification. Printed boards furnished under this specification shall be technologies that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2).

* 3.3 Design (see 6.2). Printed boards shall be of the design specified. Unless otherwise specified, if individual design parameters are not specified, then the baseline design parameters shall be as specified in either IPC-2221 and IPC-2223, type 1 or type 2, performance class 3. Test coupons shall be as specified in the applicable design standard and shall reflect worst case design conditions.

* 3.4 Printed board materials. All materials used in the construction of compliant printed boards shall comply with the applicable specifications referenced in the printed board procurement documentation. If materials used in the production of printed boards are not specified, then it is the manufacturer's responsibility to use materials which will meet the performance requirements of this specification. Acceptance or approval of any printed board material shall not be construed as a guarantee of the acceptance of the completed printed board.

* 3.5 External visual and dimensional requirements. The completed production printed boards, supporting test coupons, or qualification test specimens (hereafter referred to as printed board test specimens) shall conform to the requirements specified in 3.5.1 through 3.5.9, as applicable.

3.5.1 Base material.

* 3.5.1.1 Edges of flexible base material. The trimmed edge of completed printed boards shall be free of defects such as burrs, delaminations, nicks, or tears in excess of those allowed in 3.5.1.2 and 3.5.1.3. Following the solderability or thermal stress test, discolorations or resin recession at completed or trimmed edges of the flexible base material shall be acceptable provided that the discoloration or resin recession defect does not reduce the edge spacing below the specified requirements.

3.5.1.2 Surface imperfections. Surface imperfections (such as cuts, dents, pits, or scratches) shall be acceptable providing the imperfections meets all of the following:

* a. The imperfections do not bridge between conductors.

b. The dielectric spacing between the imperfection and a conductor is not reduced below the specified minimum conductor spacing requirements.

3.5.1.3 Subsurface imperfections. Subsurface imperfections (such as blistering, haloing, delamination, and foreign inclusions) shall be acceptable providing the imperfections meets the following:

a. The imperfections do not bridge more than 25 percent of the distance between conductors and/or plated-through holes. No more than two percent of the printed board area on each side shall be affected.

b. The imperfections do not reduce conductor or dielectric spacing below the specified minimum requirements.

c. The imperfections do not propagate as a result of testing (such as rework simulation, thermal stress, or thermal shock).

d. The longest dimension of any single imperfection is no greater than 0.80 mm (.0315 inch). In non-circuitry areas, the maximum size shall not be greater than 2 mm (.079 inch) in the longest dimension or 0.01 percent of the printed board area, maximum.

e. Following the solderability or thermal stress test, discoloration or resin recession shall be acceptable at access hole edges provided they meet the criteria of 3.5.1.1

3.5.2 Conductor pattern.

3.5.2.1 Annular ring, external. The external annular ring shall be as specified. Unless otherwise specified, the external annular ring may have in isolated areas a 20 percent reduction of the specified external annular ring due to defects such as pits, dents, nicks, or pinholes.

3.5.2.1.1 Solderable components lands. Unless otherwise specified, the annular ring may have a 20 percent reduction of the specified minimum external annular ring due to defects such as pits, dents, nicks, pinholes, and cover lay (see 3.5.3.1) or stiffener (see 3.5.9) access hole misregistration. No more than 20 percent of the annular ring circumference (72 degrees) may be affected.

3.5.2.1.2 Adhesive on lands of plated-through holes. Unless otherwise specified, the minimum external annular ring for solderable plated-through holes shall not be reduced by more than 20 percent due to adhesives extruded onto lands.

3.5.2.1.3 Adhesive on lands of unsupported holes. Unless otherwise specified, the minimum external annular ring for solderable unsupported holes shall not be reduced by more than 33 percent due to adhesives extruded onto lands.

* 3.5.2.2 Bonding of conductor to base material and lifted lands. There shall be no peeling or lifting of any land or conductor patterns from the base material. The completed printed board shall not exhibit any lifted land. (Note: See 3.6.5 for allowances for the acceptable lifting of terminal pads, i.e. lifted lands, following the thermal stress test.)

3.5.2.3 Conductor imperfections. The conductor pattern shall contain no cracks, splits or tears. Unless otherwise specified, any combination of edge roughness, nicks, pinholes, cuts or scratches exposing the base material shall not reduce each conductor width by more than 20 percent of its minimum specified width. There shall be no occurrence of the 20 percent reductions greater than 13 mm (.51 inch) or 10 percent of a conductor length, whichever is less.

3.5.2.4 Conductor finish (plating or coating). The conductor finish shall be as specified.

3.5.2.4.1 Coverage. The conductor finish shall completely cover the exposed conductor pattern. Complete coverage does not apply to the vertical conductor edges.

3.5.2.4.2 Thickness (non-destructive). The plating or coating thickness of the conductor finish shall be as specified.

3.5.2.4.3 Whiskers. There shall be no whiskers of solder or other platings on the surface of the conductor pattern.

3.5.2.5 Conductor spacing. Conductor spacing shall be as specified.

* 3.5.2.6 Conductor thickness (single sided)(non-destructive). The conductor thickness on printed boards shall be as specified. Unless otherwise specified, the minimum final conductor thickness (metal foil) shall not be reduced by more than 10 percent for deposited metal foil types or 5 percent for wrought or rolled metal foil types, from the starting metal foil nominal thickness as converted from the area weight of the foil.

3.5.2.7 Conductor width. Conductor width shall be as specified. (NOTE: See 3.5.2.3 for allowances for the acceptable reduction of the specified conductor width.)

3.5.3 Cover lay.

3.5.3.1 Access hole registration. The cover lay registration shall be such that the size or diameter of the access hole shall not reduce the component land area or minimum annular ring below the limits specified (see 3.5.2.1.1).

3.5.3.2 Delamination. There shall be no cover lay delamination along the outer edges of the cover lay. Cover lay delamination shall be acceptable providing the following conditions are met:

a. At random locations away from conductors if each delamination is no larger than 6.45 square mm (.010 square inch) (approximately 1.27 mm (.050 inch) diameter), and is not within 1.0 mm (.040 inch) of the printed wiring board edge or an access hole edge. The total number of the above delaminations shall not exceed three in any 645 square mm (1.0 square inch) of cover lay surface area.

b. Along conductor edges, the total delamination does not exceed either 0.051 mm (.02 inch) in width or 20 percent of the spacing between adjacent conductors, whichever is smaller.

* 3.5.3.2.1 After folding flexibility testing (class B only). After exposure to the folding flexibility test (see 3.7.4.4 and 4.7.4.4), there shall be no propagation of any cover lay delamination in the continuous flex area.

3.5.3.3 Solder wicking. Wicking of solder under the cover lay shall be acceptable provided the conductor spacing requirements are met.

3.5.3.4 Wrinkles or creases. Wrinkles or creases in the cover lay shall be acceptable provided the requirements of 3.5.3.2 are met.

* 3.5.4 Dimensions. The completed printed board shall meet the dimensional (such as cutouts, overallthickness, periphery, etc.) requirements specified.

3.5.5 Hole pattern accuracy. The size and location of the hole pattern in the printed board shall be as specified.

* 3.5.6 Lifted lands. The completed printed board shall not exhibit any lifted lands.

3.5.7 Layer-to-layer registration. The layer-to-layer pattern misregistration shall not exceed the specified limits. For cover lay access hole registration, see 3.5.3.1. For stiffeners access hole registration, see 3.5.9.

3.5.8 Stiffeners (see 6.5). The design, placement and acceptability requirements for stiffeners shall be as specified.

3.5.9 Stiffener access hole registration. Stiffener access hole registration shall be such that the size or diameter of the access hole shall not reduce the component land area or minimum annular ring below the limits specified (see 3.5.2.1.1).

* 3.6 Microsection requirements (for designs with plated holes only). Printed board test specimens (production printed boards or test coupons) shall conform to the requirements in 3.6.1 through 3.6.7, as applicable (see figure 1).

* 3.6.1 Conductor finish thickness (plating or coating)(destructive). The plating or coating thickness of the conductor finish shall be as specified.

3.6.2 Conductor thickness (double sided with plating)(destructive). The conductor thickness on printed boards shall be as specified. If only a starting metal foil weight is specified, the minimum final conductor thickness (metal foil or metal foil and plating, as applicable) shall not be reduced by more than 10 percent for deposited metal foil types and 5 percent for wrought or rolled metal foil types, from the nominal starting metal foil thickness as converted from the area weight of the foil.

* 3.6.3 Hole wall plating (when applicable).

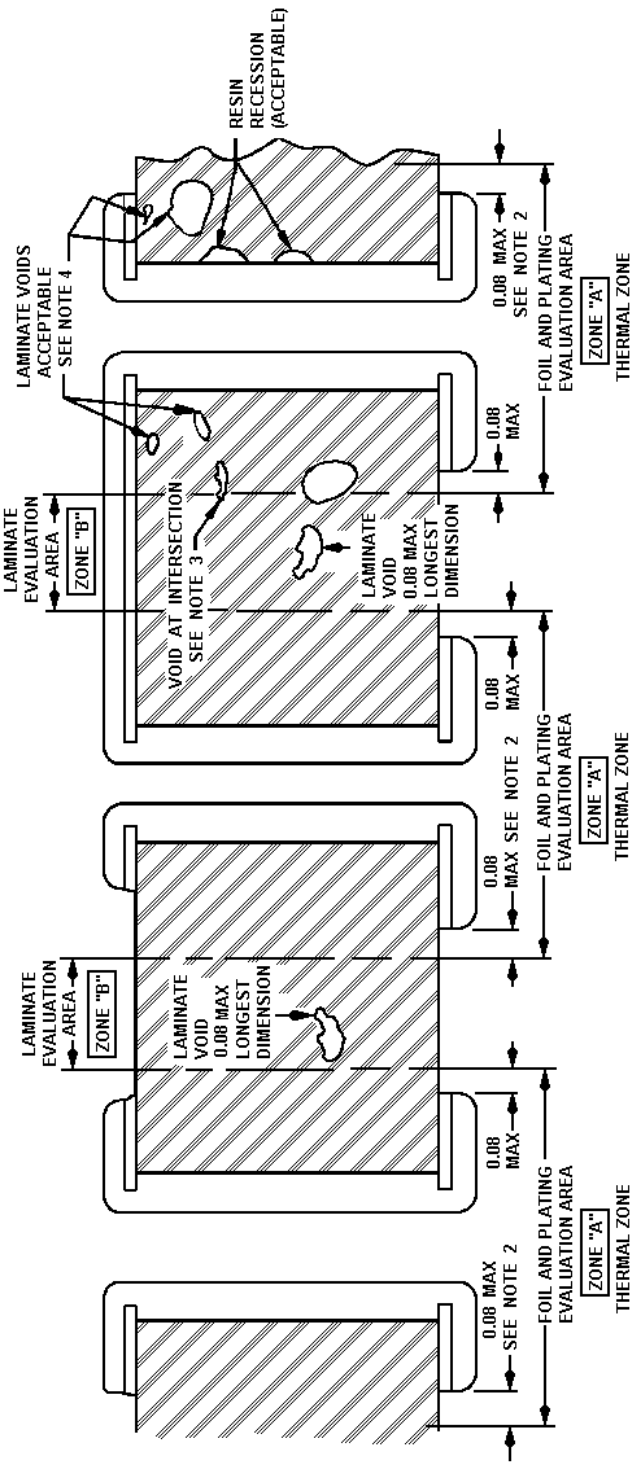
* 3.6.3.1 Copper plating thickness. Unless otherwise specified, the copper plating thickness shall be in accordance with the applicable design standard. Any copper plating thickness less than 80 percent of the specified thickness shall be treated as a void.

3.6.3.1.1 Copper plating voids. The copper plating in the plated-through hole shall not exhibit any void in excess of the following:

a. There shall be no more than one plating void per panel, regardless of length or size.

b. There shall be no plating void longer than five percent of the total printed board thickness.

Conductor finish plating or coating material between the base material and copper plating (i.e., behind the hole wall copper plating) is evidence of a void. Any plated hole exhibiting this condition shall be counted as having one void for panel acceptance purposes.



NOTES:

1. Dimensions are in millimeters.
2. Typically beyond land edge most radially extended.
3. Void at intersection of zone A and zone B. Laminate voids greater than 0.08 that extend into zone B are rejectable.
4. Laminate voids are not evaluated in zone A.

FIGURE 1. Typical plated-through hole cross section after thermal stress or rework simulation.

* 3.6.3.2 Copper plating defects. Nodules, plating folds, plating inclusions or plated reinforcement material protrusions that project into the plated-through hole shall be acceptable provided that the hole diameter and the copper thickness are not reduced below their specified limits.

* 3.6.3.3 Wicking. Wicking of copper plating extending 0.08 mm (.0031 inch) into the base material shall be acceptable provided it does not reduce the conductor spacing below the minimum clearance spacing requirements specified.

3.6.3.4 Conductive interface separations. Except for along the vertical edge of the external copper foil, there shall be no separations or contamination between the hole wall conductive interfaces. Conductive interface separations along the vertical edge of the external copper foil shall be acceptable. Anomalies resulting from this separation shall not be cause for rejection.

NOTE: The term conductive interfaces shall be used to describe the junction between the hole wall plating or coating and the surfaces of internal and external layers of copper or metal foil. The interface between platings and coating (electroless copper, direct metallization copper and non-electroless electroless copper substitutes, etc., and electrolytic copper, whether panel or pattern plated), shall also be considered a conductive interface.

* 3.6.4 Metallic cracks. There shall be no cracks in the platings or coatings. For terminal or land areas plated with copper, cracks are permissible in the underlaying copper foil provided they do not extend or propagate into the plated copper.

3.6.5 Dielectric layer thickness (layer-to-layer separation). The minimum dielectric thickness between conductor layers shall be as specified.

* 3.6.6 Laminate and adhesive voids. Laminate voids with the longest dimension of 0.08 mm (.0032 inch) or less shall be acceptable provided the conductor spacing is not reduced below the minimum dielectric spacing requirements, laterally or vertically, as specified. Adhesive voids (when applicable) in the flexible metal clad base material no greater than 0.5 mm (.020 inch) or 25 percent of conductor spacing, whichever is less, shall be acceptable. For type 2 designs, after undergoing rework simulation (see 3.7.4.6), thermal stress (see 3.7.6.2) or thermal shock (see 3.7.6.3), laminate voids are not evaluated in zone A (see figure 1).

* 3.6.7 Lifted lands (after thermal stress, rework simulation, or thermal shock). After undergoing rework simulation (see 3.7.4.6), thermal stress (see 3.7.6.2) or thermal shock (see 3.7.6.3), the maximum allowed lifted land distance from the printed board surface to the outer lower edge of the land shall be the thickness (height) of the terminal area or land. The completed, non-stressed printed board shall not exhibit any lifted lands.

* 3.7 Performance requirements. The performance requirements specified in 3.7.1 through 3.7.6 shall be verified by the test methods detailed in 4.7. Unless otherwise specified by the TRB, test optimization in accordance with MIL-PRF-31032 may be used, but the printed boards shall meet all of the performance requirements specified and herein, regardless of the verification method used.

* 3.7.1 Acceptability (of printed boards). When examined as specified in 4.7.1, the printed boards shall conform to the acceptance requirements specified in 3.3 (design), 3.4 (material), 3.5 (external visual and dimensional), 3.8 (marking), and 3.9 (workmanship).

* 3.7.2 Microsection evaluation (of printed board test specimens). When printed board test specimens (completed printed boards, supporting test coupons, or qualification test specimens) are microsectioned and examined as specified in 4.7.2, the requirements specified in 3.6 shall be met.

3.7.3 Chemical requirements.

* 3.7.3.1 Cleanliness (when specified, see 6.2.1.a and 6.4.1). When printed board test specimens are tested in accordance with 4.7.3.1, the levels of cleanliness for completed printed boards shall be as specified.

* 3.7.3.2 Copper plating characteristics.

* 3.7.3.2.1 Elongation. When copper plating is tested in accordance with 4.7.3.2, the elongation shall be 6 percent minimum.

* 3.7.3.2.2 Tensile strength. When copper plating is tested in accordance with 4.7.3.3, the tensile strength shall be 248 MPa (36,000 psi) minimum.

3.7.4 Physical requirements.

3.7.4.1 Adhesion, marking. After marking is tested in accordance with 4.7.4.1, any specified markings which are missing in whole or in part, faded, smeared, or shifted (dislodged) to the extent that it cannot be readily identified shall constitute failure. A slight change in the color of ink or paint markings after the test shall be acceptable.

3.7.4.2 Adhesion, plating. When tested as specified in 4.7.4.2, there shall be no plating particles or conductor patterns removed from the printed board test specimen except for outgrowth.

3.7.4.3 Bow and twist (designs with stiffeners and bow and twist limits only)(when specified, see 6.2.1.b and 6.4.2). When printed boards are tested as specified in 4.7.4.3, the maximum limit for bow and twist shall be as specified.

3.7.4.4 Flexibility endurance (class B only). When tested as specified in 4.7.4.4, the printed wiring board test specimen shall be capable of withstanding the specified conditions of 3.7.4.4.1 or 3.7.4.4.2, as applicable, without any evidence of damage, degradation or rejectable delamination. After the test, the requirements specified in 3.7.5.1 and 3.7.5.2 shall be met.

3.7.4.4.1 Qualification and periodic testing. A type 1 printed wiring board test specimen shall be capable of withstanding 100,000 cycles when flexed in the center of the test specimen at 6 cycles per minute with a travel loop of 30 mm (1.18 inch) minimum.

* 3.7.4.4.2 Acquiring activity specified (see 6.2.1c). The number of flexing cycles, flexing rate, and points of application of the flexing shall be specified.

3.7.4.5 Folding flexibility. When tested as specified in 4.7.4.5, printed wiring board test specimen shall be capable of withstanding the specified conditions of 3.7.4.5.1 or 3.7.4.5.2, as applicable, without any evidence of damage, degradation or rejectable delamination. After the test, the requirements specified in 3.5.3, 3.7.5.1, and 3.7.5.2 shall be met.

3.7.4.5.1 Qualification and periodic testing. The baseline folding flexibility parameters for qualification and periodic testing shall be as follows:

a. Direction of bend: Both directions (top and bottom).

b. Degree of bend: 180 degrees.

c. Point of application: Center of test specimen.

d. Diameter of mandrel: Twelve times overall material thickness, reduced to the nearest 2.5 mm (.098 inch).

e. Number of fold cycles: 25.

3.7.4.5.2 Acquiring activity specified (see 6.2.1d). The direction of bend, degree of bend, points of application of the flexing, diameter of mandrel and number of fold cycles shall be specified.

3.7.4.6 Rework simulation.

* 3.7.4.6.1 Unsupported holes. After undergoing the test specified in 4.7.4.6.1, the printed board test specimens with unsupported holes shall withstand 2.27 Kg (5 pounds) pull or 3.45 MPa (500 pounds per square inch), whichever is less.

* 3.7.4.6.2 Plated holes. After undergoing the test specified in 4.7.4.6.2, the printed board test specimens shall be microsectioned and inspected in accordance with 4.7.2 and the requirements specified in 3.6 shall be met.

3.7.4.7 Solderability (see 6.2.1.e).

3.7.4.7.1 Hole solderability. After undergoing the test specified in 4.7.4.7, the printed board test specimen shall conform to the class 3 acceptance criteria specified in J-STD-003.

3.7.4.7.2 Surface solderability. After undergoing the test specified in 4.7.4.7, the printed board test specimen shall conform to the class 3 acceptance criteria specified in J-STD-003.

3.7.5 Electrical requirements.

* 3.7.5.1 Continuity (when specified, see 6.2.1.f). When tested in accordance with 4.7.5.1, unless otherwise specified, there shall be no circuit whose resistance exceeds 10 ohms. For referee purposes, 0.5 ohm maximum per 25 mm (.98 inch) of circuit length shall apply.

3.7.5.2 Isolation (when specified, see 6.2.1.f). When tested as specified in 4.7.5.2, the resistance between mutually isolated conductors shall be greater than 100 megohms.

3.7.6 Environmental requirements.

3.7.6.1 Moisture and insulation resistance. When tested as specified in 4.7.6.1, the printed board test specimen shall have a minimum of 500 megohms of resistance between conductors. After the test, the printed board test specimen shall not exhibit blistering or delamination in excess of that allowed in 3.5.1, 3.5.2, and 3.5.3.

3.7.6.2 Thermal stress.

* 3.7.6.2.1 Type 1. After undergoing the test specified in 4.7.6.2, the printed board test specimen shall be inspected in accordance with 4.7.1 and not exhibit any cracking or separation of plating or conductors, terminals or lands shall not lift in excess of that allowed in 3.6.7, and shall meet the requirements of 3.5.1 and 3.5.3, inclusive.

* 3.7.6.2.2 Type 2. After undergoing the test specified in 4.7.6.2, the printed board test specimen shall be inspected in accordance with 4.7.1 and shall meet the requirements of 3.5.1 and 3.5.3, inclusive. The printed board test specimen shall then be microsectioned and inspected in accordance with 4.7.2 and shall meet the requirements of 3.6.

3.7.6.3 Thermal shock. After undergoing the test specified in 4.7.6.3, the printed board test specimens shall meet the following requirements:

a. Visual inspection: When inspected as specified in 4.7.1, there shall be no evidence of plating cracks, blistering, crazing, or delamination in excess of that allowed in 3.5.

* b. Resistance change: When tested as specified in 4.7.5.1, the change in resistance between the first high temperature cycle and the last high temperature cycle shall not be more than 10 percent.

c. Microsection (double side with plated hole only): The printed board test specimen shall be microsectioned and inspected in accordance with 4.7.2 and the requirements specified in 3.6 shall be met.

3.8 Marking. Marking shall be in accordance with MIL-PRF-31032.

* 3.9 Workmanship. Printed boards shall be processed in such a manner as to be uniform in quality and shall be free from defects that will affect life, serviceability, or appearance.

4. VERIFICATION

* 4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

* a. Qualification inspection (see 4.2).

* b. Conformance inspection (see 4.3 and tables I and II).

* c. Capability verification inspection (see 4.6).

4.1.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-PRF-31032, and as specified herein.

4.1.2 Standard test and inspection conditions. Unless otherwise specified by the applicable test method or procedure, inspections and tests may be performed at ambient conditions.

4.2 Qualification inspection. Unless otherwise specified by the Technical Review Board (TRB) approved qualification test plan, qualification inspection shall be in accordance with MIL-PRF-31032 and as specified herein.

4.2.1 Qualification test vehicles. The qualification test vehicle(s) to be subjected to qualification inspection shall be in accordance with the TRB approved qualification test plan and the applicable qualification test vehicle specification(s).

4.2.1.1 Sample. The number of qualification test vehicle(s) to be subjected to qualification inspection shall in accordance with TRB approved qualification test plan.

* 4.2.2 Test routine. The qualification test vehicle(s) shall be subjected to the inspections and tests specified in tables I and II in addition to thermal shock in accordance with 3.7.6.3 and 4.7.6.3.

4.2.3 Qualification by similarity. A production lot may be considered qualified by similarity if the dimension parameters are within twenty-five percent of that which is currently qualified. This window is applicable on an associated specification basis.

* 4.3 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-31032 and shall consist of lot conformance inspection (see 4.4) and periodic conformance inspection (see 4.5).

4.4 Lot conformance inspection. Lot conformance inspection shall be in accordance with MIL-PRF-31032 and table I herein. Lot conformance inspection testing by subgroup or within a subgroup may be performed in any sequence.

4.4.1 Sample inspections. Panels and printed boards to be delivered in accordance with this specification shall have been subjected to and passed all the inspections of table I, subgroups 1, 2, 3, and 4.

4.4.1.1 Sampling. A sample of printed boards (or test coupons that represent the printed boards) shall be randomly selected from each inspection lot.

* TABLE I. Lot conformance inspection.

Inspection	Requirement paragraph	Method paragraph	Specimen to test 1/				Sample plan 2/
			PWB	THM	SMT	MIX	
Subgroup 1							
* Thermal stress	3.7.6.2	4.7.6.2		A & B	A & B	A & B	Plan TH
Subgroup 2							
Acceptability: 3/							
Design	3.3	4.7.1	X				Plan BF
Material	3.4	4.7.1	X				Plan BF
Visual and dimensional	3.5	4.7.1	X				Plan BF
Marking	3.8	4.7.1	X				Plan BF
Workmanship	3.9	4.7.1	X				Plan BF
Subgroup 3							
Physical:							
Adhesion, marking	3.7.4.1	4.7.4.1	X				Plan BH or TJ 3/
Adhesion, plating 3/	3.7.4.2	4.7.4.2	X	C	C	C	Plan BH or TJ 3/
Bow and twist	3.7.4.3	4.7.4.3	X				Plan BH
Solderability							
Hole	3.7.4.7.1	4.7.4.7		S or A		A or S	Plan TJ
Surface	3.7.4.7.2	4.7.4.7			C or M	C or M	Plan TJ
Subgroup 4							
Electrical:							
Continuity	3.7.5.1	4.7.5.1	X				Plan BH 4/
Isolation resistance	3.7.5.2	4.7.5.2	X				Plan BH 4/

* 1/ Test coupons are in accordance with IPC-2221. PWB is a production board; THM is a through-hole mount test coupon; SMT is a surface mount PWB test coupon; MIX is a Mixed mounting test coupon.
2/ See MIL-PRF-31032 for C = 0 sampling plans.
3/ Test coupon, production panel, or production printed board, manufacturer option.
4/ At the acquiring activity's option for designs that will have only connector joined to the completed assembly, electrical testing can be performed at the assembly level (see 6.2.1.f).

* 4.5 Periodic conformance inspection. Periodic conformance inspection shall be in accordance with TRB approved periodic conformance inspection plan and table II herein.

* 4.5.1 Sampling. Sample units shall be selected randomly from the most complex printed board inspection lot that has passed all the lot conformance inspections during that production month. The method for determining the most complex printed board shall as described in the manufacturer's TRB approved quality management plan (see MIL-PRF-31032).

* TABLE II. Periodic conformance inspection baseline test coverage.

Inspection	Requirement paragraph	Method paragraph
Elongation Tensile strength	3.7.3.2.1 3.7.3.2.2	4.7.3.2 4.7.3.3
Flexibility endurance Folding flexibility	3.7.4.4 3.7.4.5	4.7.4.4 4.7.4.5
Rework simulation Moisture and insulation resistance	3.7.4.6 3.7.6.1	4.7.4.6 4.7.6.1

* 4.6 Capability verification inspection. Capability verification inspection shall be in accordance with the TRB approved capability verification inspection plan. The frequency of this verification shall be as a minimum every 2 years. Each base material type qualified shall be verified. The following tests and inspections should be considered when accomplishing capability verification inspection: thermal shock, rework simulation, moisture and insulation resistance testing.

4.7 Methods of inspection.

4.7.1 Visual and dimensional inspection. The printed board specimen shall be inspected in accordance with test method number 2.1.8 of IPC-TM-650, except that the magnification shall be 1.75x (3 diopters), minimum.

4.7.2 Microsection inspection (double sided). Microsection inspections shall be accomplished by using methods in accordance with either test method number 2.1.1 or 2.1.1.2 of IPC-TM-650. Referee inspections shall be accomplished at a magnification of 200x.

4.7.3 Chemical test methods.

4.7.3.1 Cleanliness. The sodium chloride (NaCl) salt equivalent ionic contamination tests of 4.7.3.1.1 or 4.7.3.1.2 all be used to test for ionic cleanliness.

4.7.3.1.1 Manual method. The test for cleanliness shall be performed in accordance with test method number 2.3.25 of IPC-TM-650.

* 4.7.3.1.2 Automatic methods. The test for cleanliness shall be performed in accordance with test method number 2.3.25 of IPC-TM-650.

* 4.7.3.2 Elongation of copper. The test for elongation of copper shall be performed in accordance with ASTM E345. The travel speed of testing shall be 50 mm ± 1 mm (1.97 ± .03 inches) per minute.

* 4.7.3.3 Tensile strength of copper. The test for tensile strength of copper shall be performed in accordance with ASTM E345. The travel speed of testing shall be 50 mm ± 1 mm (1.97 ± .03 inches) per minute.

4.7.4 Physical test methods.

4.7.4.1 Adhesion, marking. Test specimens which represent all types of marking used on the lot (except etched marking) shall be subjected to the solderability test in 4.7.4.7. The side of the test specimen that is marked shall be placed against the solder. After the test, the test specimen shall be examined in accordance with 4.7.1 and the requirements of 3.7.4.1 shall be met.

* 4.7.4.2 Adhesion, plating. The test for plating adhesion shall be performed in accordance with test method number 2.4.1 of IPC-TM-650. If overhanging metal break off and adheres to the tape, it is evidence of outgrowth, overhang or slivers, but not of plating adhesion failure.

4.7.4.3 Bow and twist. The tests for bow and twist shall be performed in accordance with test method number 2.4.22 of IPC-TM-650.

4.7.4.4 Flexibility endurance.

* 4.7.4.4.1 Qualification and lot acceptance tests. The flexibility endurance test shall be in accordance with test method number 2.4.3 of IPC-TM-650.

4.7.4.4.2 Acquiring activity specified. The flexibility endurance test shall be in accordance with test method number 2.4.3 of IPC-TM-650. The following details shall be specified (see 6.2.1c):

a. Number of flex cycles.

b. Diameter of mandrel.

c. Flexing rate.

d. The length of travel of loop.

4.7.4.5 Folding flexibility. The folding flexibility test shall be performed in accordance with 4.6.4.5.1.

4.7.4.5.1 Fold cycle. A fold cycle shall be defined as taking one end of the specimen and folding it around a mandrel and then unfold back to the original starting position, traveling 180 degrees in one direction and 180 degrees in the opposite direction. A fold cycle may also be defined as folding (using opposite ends) the ends toward each other (fold the same direction) and then unfold back to the original starting position, with each end traveling 90 degrees in one direction and 90 degrees in the opposite direction. The specified number of fold cycles shall be performed with the mandrel placed in contact with the specimen on one side and then again with the mandrel placed in contact with the specimen on the opposite side.

4.7.4.6 Rework simulation.

4.7.4.6.1 Single and double sided without plated holes. The rework simulation test shall be performed in accordance with test method number 2.4.20 of IPC-TM-650.

4.7.4.6.2 Double sided with plated holes. The rework simulation test shall be performed in accordance with test method number 2.4.36 of IPC-TM-650.

4.7.4.7 Solderability. The tests for hole or surface solderability shall be performed in accordance with J-STD-003.

4.7.5 Electrical test methods.

4.7.5.1 Continuity. A current shall be passed through each conductor or group of interconnected conductors by applying electrodes on the terminals at each end of the conductor or group of conductors. The current passed through the conductors shall not exceed those specified in the applicable design standard for the smallest conductor in the circuit.

* 4.7.5.2 Isolation (circuit shorts). A test voltage shall be applied between all common portions of each conductor pattern and all adjacent common portions of each conductor pattern. The test voltage shall be applied between conductor patterns of each layer and the electrically isolated pattern of each adjacent layer (when applicable). For manual testing the test voltage shall be 200 volts minimum and shall be applied for a minimum of 5 seconds. When automated test equipment is used, the minimum applied test voltage shall be the maximum rated voltage specified. If the maximum rated voltage on the printed board is not specified, the test voltage shall be 40 volts minimum.

4.7.6 Environmental test methods.

4.7.6.1 Moisture and insulation resistance. The test for moisture and insulation resistance shall be performed in accordance with class 3 of test method number 2.6.3 of IPC-TM-650.

4.7.6.2 Thermal stress. The test for thermal stress shall be performed in accordance with condition A of test method number 2.6.8 of IPC-TM-650.

4.7.6.3 Thermal shock. The test for thermal shock shall be performed in accordance with test method number 2.6.7.2 of IPC-TM-650 except that the temperature extremes shall be –65 degrees Celsius and +125 degrees Celsius for all flexible base materials and cover lay combinations.

5. PACKAGING

5.1 Packaging requirement. The requirement for packaging shall be in accordance with MIL-PRF-31032.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-31032 are applicable to this specification.

* 6.1.1 Intended use. This associated specification was developed for the use of verifying performance characteristics of flexible single or double sided (1 or 2 conductor layers) printed wiring boards with or without plated holes, that will use soldering for component/part mounting. Other single and double sided printed board technology types can be verified to the requirements contained in this document, however, the performance parameters and baseline verification methods of other associated specifications may be more appropriate.

6.2 Acquisition requirements. Acquisition documents must specify the following:

* a. Title, number, revision letter and date of this specification.

* b. The specific issue of individual documents referenced (see section 2).

c. Title, number and date of applicable printed board procurement documentation or drawing and identification of the originating design activity.

* d. The complete product procurement documentation part or identifying number (see 3.1).

e. The printed wiring board type classification (type 1 or 2, see 1.2.1 and 3.1).

f. The printed wiring board usage classification (class A or B, see 1.2.2 and 3.1).

g. Requirements for delivery of one copy of the quality conformance inspection data pertinent to the product inspection lot to be supplied with each shipment by the QML manufacturer, if applicable.

h. Requirements for certificate of compliance, if applicable.

i. Requirements for notification of change of product or process to the contracting activity in addition to notification to the qualifying activity, if applicable.

j. Levels of preservation and packing required.

k. If special or additional identification marking is required (see 3.8).

l. Government approved deviation list for printed board procurement documentation, if applicable.

6.2.1 Optional acquisition data. The following items are optional and are only applicable when specified in the printed board procurement documentation.

a. Special or additional cleanliness is required (see 3.7.3.1 and 6.4.1).

b. Special requirements for bow and twist (see 3.7.4.3 and 6.4.2).

c. Special requirements for flex endurance (see 3.7.4.4).

d. Special requirements for folding flexibility (see 3.7.4.5).

e. The durability of coating rating (accelerated aging for solderability testing) if other than category 2 (see J-STD-003, 3.7.4.7).

f. Special requirements for electrical testing at the assembly level (see table 1, footnote 5).

g. Disposition of lot conformance inspection sample units.

h. Requirements for failure analysis, corrective action and reporting of results.
i. Any other additional special requirements.

6.3 Replacement information. This specification includes a majority of the performance requirements of previous revisions of MIL-P-50884 for types 1 and 2 printed wiring boards. Printed wiring boards conforming to this associated specification would be comparable to printed wiring boards conforming to MIL-P-50884.

6.4 Notes regarding optional verification testing.

6.4.1 Cleanliness. This optional verification test is not listed in Table I, Lot Conformance Inspection. If verification is required, the acquiring activity should specify acceptability requirements and test specimen sampling frequency.

6.4.2 Bow and twist. This optional verification test is not listed in Table I, Lot Conformance Inspection. If verification is required, the acquiring activity should specify acceptability requirements and test specimen sampling frequency.

6.5 Stiffener adhesion test and requirement. This document does not include the stiffener adhesion test or requirement contained in MIL-P-50884. All stiffeners are viewed as a mechanical support and total bonding of the stiffener to the printed board is not required for compliance with this document.

* 6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

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Review activities:
Army - MI
Navy - CG
Air Force - 99

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